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KEY TO NINE UBIQUITOUS SOIL-BORNE PHOMA-LIKE FUNGI

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(With six Plates)

The differentiating characteristics on agar-media of *Pyrenochaeta acicola*, *Phoma chrysanthemicola*, *P. eupyrena*, *P. fimeti*, *P. glomerata*, *P. herbarum*, *P. medicaginis* var. *pinodella*, and *P. prunicola* are discussed and illustrated. In a supplementary note the nomenclature of *Pyrenochaeta acicola*, *Phoma chrysanthemicola*, *P. eupyrena*, and *P. fimeti* is recorded.

In the course of time various *Phoma*-like fungi have been received which had more or less frequently been isolated from soil in Germany and the Netherlands. Several of these isolates proved to be identical with species regularly isolated in our mycological diagnostic work on diseased and dying-off plants. In this paper the diagnostic characters of nine of these ubiquitous *Phoma*-like fungi—generally necrotrophic or perthotrophic—are compared and tabulated to provide a usable identification method for them.

It should be realized that *Phoma*-like fungi of this kind cannot be differentiated and identified in culture by a few special characteristics only since none of the morphological and physiological characters is truly specific. For example a typical feature of the common saprophyte *Phoma herbarum* Westend. is produced by a reddish pigment, the colour changing to blue when NaOH is added, but the same kind of pigment occurs in various other *Phoma* species. In many species the spore dimensions, although an important differential character, are about the same size. Some of the typical features appear to be unstable while others become evident only after a long period of growth. Furthermore the conditions of growth on the agar-media greatly influence the morphological and physiological characters of the fungi.

From the above it may be gathered that Table 1, far from being a definitive key, is merely a comparative survey. This table is only usable by applying the same methods we employed, and by consulting the additional notes on the species listed. These notes include references to the literature, which gives detailed morphological descriptions, generally together with discussions on the nomenclature. The nomenclature of four species, *Pyrenochaeta acicola*, *Phoma chrysanthemicola*, *P. eupyrena*, and *P. fimeti* is treated in a supplementary note at the end of this paper.

Methods

The fungi are compared in plate cultures on oatmeal-agar (abbreviated OA) and malt-agar (MA), prepared after the formulae given by Ainsworth (1961: 241, 242). OA is used because it stimulates the production of pycnidia and pycnidiospores; MA stimulates the mycelial growth, the production of chlamydospores, and crystal-formation.

The plates are inoculated in the centre by a punched-out piece of agar with pycnidia and placed in a dark incubator at 20–22° C for one week. The diameter of the colonies is subsequently measured and the cultures are exposed (not uncovered) to artificial daylight in order to stimulate sporulation and possibly pigment-production. It should be noted that the pigment may take a few days to several weeks to form, depending on the species and, more particularly, the strain involved. The development of dictyochlamydospores often takes quite some time as well. The best impression of the general habitus can be obtained at an early stage of growth. At that time the character of the margin of the colony is clearly determinable and the colours of the mycelium are fresh and differentiated into delicate shades.

The spore dimensions given are always taken from colonies on OA; on MA the spores are usually swollen (and therefore broader) and more guttulate.

A useful diagnostic test is the addition of a drop of concentrated alkali, e.g. NaOH-N. In *Phoma exigua* this causes the oxidation of a metabolite 'E', resulting in the successive production of characteristic bluish-green and red pigments (see Boerema & Höweler, 1967). Although the other species remain unaltered, it may be pointed out that a similar oxidation-reaction is known to occur in *Phoma*-like fungi not discussed in the present paper. The bluish-green discoloration after the addition of a drop of NaOH usually occurs within a few minutes, but it may take longer. The production of metabolite 'E' is stimulated by light, so that the NaOH-test is best examined after the plates have been exposed to daylight for several days. In order to examine whether the pigment changes colour in alkaline condition or not, a drop of NaOH-N is also added to cultures of species which produce pigment naturally; see under *Phoma chrysanthemicola*, *P. fimeti*, and *P. herbarum*.

Discussion of the species

Pyrenochaeta acicola (Lév.) Sacc. *in* Sylloge Fung. **3**: 220. 1884.—See remarks on nomenclature at the end of this paper. — Pl. 3 figs. 1, 2; Pl. 5 figs. 3, 4.

Cultural description.—Gams & Domsch *in* Nova Hedwigia **18**: 17. 1969.

The colonies of *P. acicola* are grey to dull 'Cladosporium-green' in appearance. Some strains show a lilac-rose discoloration of the medium below and around the colony. This discoloration may be quite conspicuous, but as it occurs only occasionally it is not mentioned in the table. The lilac-rose pigment does not change colour on application of NaOH.

A characteristic feature is the occurrence of setae on the pycnidia (Pl. 5 figs. 3, 4).

These vary from few to many, from stiff to rather hypha-like, and from short to relatively long.

Some strains produce broad spores with many guttules; other strains have narrow spores, usually with two guttules (see Table 1).

This common soil-fungus (compare Gams & Domsch, 1969a) has also been found on, and isolated from, leaves and seedlings of *Pinus* species, wood of *Ribes* and *Populus* species, and stem bases of *Callistephus* and *Campanula* species. It appears to be capable of destroying wood (Haider & Domsch, 1969: 341).

Phoma chrysanthemicola Hollós *in* Annls hist.-nat. Mus. natn. hung. **5**: 456. 1907.—See nomenclatural remarks at the end of this paper. — Pl. 1 fig. 1; Pl. 3 figs. 3, 4; Pl. 6 figs. 1, 2.

Cultural descriptions and illustrations.—Kemp *in* Can. J. Pl. Sci. **38**: 469, figs. 1D (pycnidia), 2A (growth rate of colonies). 1958; Hawkins, Wiggell & Wilcox *in* Pl. Path. **12**: 21, pl. 1 (pycnidia). 1963.

The colonies of *P. chrysanthemicola* are evenly pale to dark grey, but in other respects they may vary a great deal. Some isolates produce abundant aerial mycelia which are dense or loose, while in others the mycelia are much less conspicuous. Most isolates grow rather slowly.

The characteristic orange-red discoloration of the agar-media (Pl. 1 fig. 1) appears in closed or interrupted concentric zones. Addition of NaOH causes the red colour to fade. Incidentally the medium may show locally a yellow discoloration.

An important diagnostic character is the occurrence of dark brown to black structures that look like pseudosclerotial masses and consist of chlamydospores (Pl. 6 figs. 1, 2 and Table 1). These structures, very irregular in shape and size, may be present in abundance in the aerial mycelium. Unfortunately, however, they are not produced by all strains (see also the remarks on nomenclature at the end of this paper).

The pynidia of the present fungus sometimes fuse to form large irregular fructifications with many ostioles.

This fungus is repeatedly isolated from soil and is well known as the causal organism of a root-rot of florists' chrysanthemums (epidemiology recently studied by Peerally & Colhoun, 1969; see also the remarks on nomenclature at the end of this paper). In the Netherlands the fungus has also been isolated from *Chrysanthemum leucanthemum*, *Achillea millefolium*, and other wild plants, which makes its isolation from soil comprehensible. The fungus appears to be capable of destroying wood (Haider & Domsch, 1969: 341).

Phoma eupyrena Sacc. *in* Michelia **1** (5): 525. 1879.—See nomenclatural remarks at the end of this paper. — Pl. 4 figs. 1, 2; Pl. 6. fig. 3.

Cultural descriptions and illustrations.—Dennis *in* Trans. Br. mycol. Soc. **29**: 30, 31 ('Group VII'), pl. 2 fig. 1 (culture on MA). 1946; Kranz *in* Sydowia **16**: 15, 16. 1963.

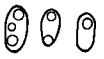
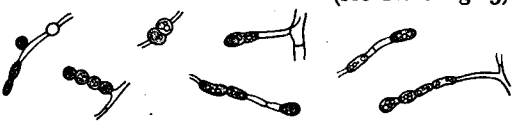
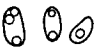
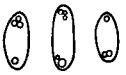
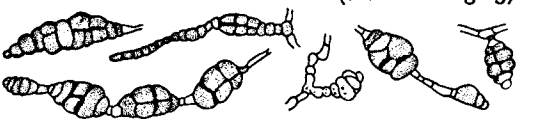
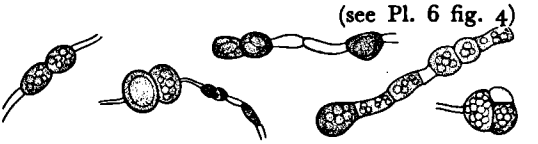
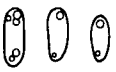
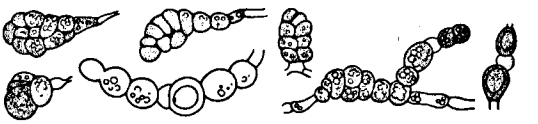
The colonies of *P. eupyrena* are characterized by a dense mycelial growth, which is dark green at first but soon turns black.

A useful specific character is the production of typical small chlamydospores,

TABEL I — DIFFERENTIAL CRITERIA OF SPECIES CULTURED ON AGAR

	Macroscopic characters		
	Metabolites	Special growth features	Diameter of colony in cm after culture in the dark at 20–22° C for one week on MA and OA (⟷ = variation)
Pyrenochaeta acicola		Setae on pycnidia (Pl. 5 figs. 3, 4)	2 3
Phoma chrysanthemicola	Orange-red pigment: production stimulated by daylight (Pl. 1 fig. 1)		2 4
Phoma eupyrena			4 5
Phoma exigua	Substance 'E' (see Boerema & Höweler, 1967): demonstrable by addition of NaOH: bluish-green pigment ⇄ red pigment (Pl. 1 fig. 2)	Margin of colony irregularly scalloped or lobed (Pl. 4 figs 3, 4)	2 8
Phoma fimeti	Yellow pigment on OA (Pl. 1 fig. 3)		1.5 3
Phoma glomerata			5 7.5
Phoma herbarum	Red pigment: production stimulated by daylight: with addition of NaOH staining violet-blue (Pl. 1 figs. 4, 5)		3.5 4.5
Phoma medicaginis var. *pinodella*	Production of crystals on MA (Pl. 5 figs. 1, 2)		4 6.5
Phoma prunicola			5 7.5

1. A diagram of a 2-celled spore indicates the frequent occurrence of 1- (or pluri-) septate spores. In the other species septate spores may occur, but only incidentally.

Microscopic characters		
Shape and structures of spores and relative size-ratio (*c.* × 1250) on OA	Dimensions of 1-celled spores on OA	Shape and structure of chlamydospores (*c.* × 250)
	3–7 × 1–3 μ	
	3.5–6.5 × 1.5–2.5 μ	(see Pl. 6 figs. 1, 2) 
	3.5–6 × 1.5–3 μ	(see Pl. 6 fig. 3) 
	3.5–10 × 2–3.5 μ	
	2.5–5 × 1.5–3 μ	
	4–8.5 × 2–3.5 μ	(see Pl. 6 fig. 5) 
	3.5–8 × 1.5–3 μ	
	4–9 × 2–4 μ	(see Pl. 6 fig. 4) 
	4–8 × 2–3.5 μ	(see Pl. 6 fig. 6) 

2. Unusually small and large spore dimensions have not been taken into account.

originating singly or in chains (Pl. 6 fig. 3 and Table 1). These chlamydospores are usually present in abundance, but their production may take more than a week. In many aspects they resemble those of *Verticillium nigrescens*, also a soil-borne fungus.

This species proves to be one of the most common soil-inhabiting members of the genus *Phoma* (compare Gams & Domsch, 1967: 140; Domsch & *al.*, 1968: 141; and Gams & Domsch, 1969b). It is known especially as a secondary unharmful organism on potato tubers (Malcolmson, 1958; Boerema & van Kesteren, 1962), but it has also been repeatedly isolated from the underground parts of all kinds of other plants.

Phoma exigua Desm. *in* Annls Sci. nat. (Bot.) III, **11**: 282, 283. 1849.—Pl. 1 fig. 2; Pl. 4 figs. 3, 4.

Synonyms: *Phoma solanicola* Prill. & Delacr., *Phyllosticta decidua* Ell. & Kell.; for further synonyms, see Boerema & Höweler (1967) and Boerema (1970).

Cultural descriptions and illustrations.—Dennis *in* Trans. Br. mycol. Soc. **29**: 21–26 ('Group II'), table 3 (range of spore dimensions), pl. 1 figs. 4–6 (cultures on MA). 1946; Boerema & Höweler *in* Persoonia **5**: 15–25, table 1 (diagnostic criteria), figs. 1–4 (shape and size of pycnidia and spores), pl. 3 figs. 1–4 (cultures on MA and cherry-agar), pl. 4 figs. 1–7 (colour plate of characteristic oxidation-reaction). 1967.

A characteristic feature of the colonies of *P. exigua* is the irregularly scalloped or lobed margin, see Pl. 4 figs. 3, 4. This feature, however, is not always seen as clearly as it appears in these photographs. The colonies are extremely variable as to habitus and growth rate. Generally they are flat and dense, white to black, with various greenish and grey tinges. Light coloured colonies often grow fast, producing abundant pycnidia. Predominantly dark colonies usually grow relatively slowly, producing much aerial mycelium and barely sporulating pycnidia. Whitish or greyish aerial mycelium often occurs locally in loose tufts, consisting mostly of broadly swollen hyphae.

A workable diagnostic criterium is the bluish-green discoloration of the agar-media on application of a drop of NaOH (oxidation-reaction of metabolite 'E', see under 'Methods'). This blue-green colour (pigment α) gradually passes into brown-red (pigment β), see Pl. 1 fig. 2. Some strains show a very conspicuous blue-green spot when treated with a drop of NaOH, while others show only a pale green ring.

This soil-borne fungus is the most frequent *Phoma* species on herbaceous plants (see Boerema & Höweler, 1967). As a weak or wound parasite it has often been associated with such distinct disease symptoms as leafspots, fruitspots, lesions on stems and roots, damping-off, and dieback. It has further been shown to have an inhibitory effect on the root development of some plants (see Domsch & Gams, 1968a: 67).

Phoma fimeti Brun. *in* Bull. Soc. bot. Fr. **36** (=II, **11**): 338. 1889.—See remarks on nomenclature at the end of this paper. — Pl. 1 fig. 3; Pl. 2 figs. 1, 2; Pl. 5 figs. 5, 6.

Cultural characters.—Not described previously.

Colonies of *P. fimeti* show a loose vividly green mycelial growth on OA; on MA the growth is denser and the colour ashen. All the isolates tested prove to be very uniform in habitus.

A specific character is the yellow discoloration of the OA-medium (Pl. 1 fig. 3), occurring in dark as well as in daylight cultures. All the isolates tested showed the presence of this pigment. In several colonies it takes some time to appear, often more than a week, but in the end it is always very conspicuous. The yellow colour does not change on application of a drop of NaOH.

The pycnidia always possess conspicuous circular ostioles, see Pl. 5 figs. 5, 6.

This soil-fungus, originally described from dung of sheep, has also been isolated from paint, wood, and dead tissue of various plant species.

Phoma glomerata (Corda) Wollenw. & Hochapf. *in* Z. ParasitKde **8**: 592. 1936.—Pl. 2 figs. 5, 6; Pl. 6 fig. 5.

Synonyms: *Peyronellaea glomerata* (Corda) Goid. ex Togl., *Phoma alternariaceum* Brooks & Searle, *Phoma fumaginoides* Peyron., *Phoma saprophytica* Eveleigh; for further synonyms, see Boerema & *al.* (1965, 1968).

Cultural descriptions and illustrations.—Boerema, Dorenbosch & van Kesteren *in* Persoonia **4**: 52–59, fig. 2 (pycnidiospores and dictyochlamydospores), pls. 1 (dictyochlamydospores), 2 (cultures on OA and cherry agar). 1965; Morgan-Jones *in* C.M.I. Descr. path. Fungi Bact. No. 134 (pycnidia, pycnidiospores, dictyochlamydospores, mycelium). 1967.

The colonies of *P. glomerata* are generally characterized by the production of abundant pycnidia and little aerial mycelium (which causes it to resemble *Phoma herbarum*, see below); however, sectors with dense woolly mycelia may also occur. The colours of the colony vary from dull dark yellow-green to various shades of grey. On application of NaOH the medium discolours to tea-brown and even more so on MA.

The typical character of this species is the occurrence of *Alternaria*-like chains of dictyochlamydospores (see Pl. 6 fig. 5 and Table 1), but these often occur only after a long period of growth. Old colonies may look black on account of the development of these dictyochlamydospores in the aerial mycelia.

This fungus is one of the few *Phoma*-species mentioned by name in studies on soil-fungi; this should be ascribed to its typical diagnostic features (dictyochlamydospores) rather than to the frequency of its occurrence in soil. The fungus is ubiquitous on a wide variety of substrates and has been found in association with dead diseased material of all kinds of plants as well as with a number of mycotic diseases of man (Boerema & *al.*, 1965). Usually it is a secondary invader.

Phoma herbarum Westend. *in* Bull. Acad. r. Belg. Cl. Sci. **19** (3): 118. 1852.—Pl. 1 figs. 4, 5; Pl. 2 figs. 3, 4.

Synonyms: *Phoma oleracea* Sacc., *Phoma pigmentivora* Massee, *Phoma hibernica* Grimes & *al.*, *Phoma violacea* (Bertel) Eveleigh; for further synonyms, see Boerema (1964, 1970).

Cultural descriptions and illustrations.—Dennis *in* Trans. Br. mycol. Soc. **29**: 33–35 ('Group X'), pl. 2, figs. 3, 10 (cultures on MA). 1946; Eveleigh *in* Trans. Br. mycol. Soc. **44**: 578–582. 1961; Boerema *in* Persoonia **3**: 9–16, pl. 1 figs. 5–6

(cultures on MA and Ashby-agar), pl. 2 figs. 1–6 (pycnidial primordia, pycnidiospores). 1964.

The colonies of *P. herbarum* are generally characterized by the production o abundant pycnidia and sparse mycelia (pycnidial-type), see Pl. 1 fig. 5; however, strains which produce more aerial mycelium also occur, usually in sectors (mycelial-type), see Pl. 1 fig. 4. Strains of the pycnidial-type may be mistaken for *Phoma glomerata* (see above), but *P. herbarum* never produces (dictyo-)chlamydospores. The colours of the colonies vary between grey and green. A notable feature of the numerous isolates tested is the uniform rate of growth.

A typical character is the production of a reddish pigment (Pl. 1 figs. 4, 5). Of the numerous isolates tested, only two failed to produce any pigment. It is especially strains of the mycelium-type that are inclined to be strongly pigmented so that application of NaOH makes the change from red to blue very conspicuous. In very old colonies the red pigment changes from red to blue by itself. The addition of NaOH has no effect on uncoloured isolates.

The fungus is a ubiquitous typically saprophytic organism, occurring on a very wide variety of industrial products like butter, paint, cement, rubber, etc. (see Boerema, 1964). In many studies on soil-fungi it is reported as a typical soil-borne *Phoma* species, usually under the name *P. hibernica*. Its frequent occurrence on dead seed coats has led to confusion with seed-borne pathogens.

Phoma medicaginis Malbr. & Roum. var. *pinodella* (L. K. Jones) Boerema *apud* Boerema, Dorenbosch & Leffring *in* Neth. J. Pl. Path. **71**: 88. 1965.—Pl. 4 figs. 5, 6; Pl. 5 figs. 1, 2; Pl. 6 fig. 4.

Synonyms: *Ascochyta pinodella* L. K. Jones, *Phoma trifolii* E. M. Johnson & Valleau.

Cultural descriptions and illustrations.—L. K. Jones *in* Bull. N.Y. St. agric. Exp. Stn **547**: table 2 (range of spore dimensions), pl. 1 (colour plate of culture on OA). 1927; Wehlburg, Onderz. Erwtenanthracnose (Thesis, Baarn) 12, fig. 2a (shape and size of pycnidia and spores), pl. 3 (culture on OA). 1932; Boerema, Dorenbosch & Leffring *in* Neth. J. Pl. Path. **71**: 83, fig. 2 (cultures on cherry-agar, crystals). 1965.

The colonies of *P. medicaginis* var. *pinodella* are flat, with mycelial colours varying from light grey to black. Pycnidia usually develop in radial rows, but they may also be found scattered throughout the colony.

A characteristic feature is the occurrence of crystals on MA, see Pl. 5 figs. 1, 2; the production of these varies according to the different strains; the crystals are often found only after some weeks of growth. In isolates with abundant crystal production they occur not only on MA, but also on OA.

A typical and stable character is the production of chlamydospores, see Pl. 6 fig. 4. These are usually found in abundance in the dark sectors of the colony after one week of growth.

The fungus is seed- and soil-borne and well known as a weak parasite of pea (footrot and leafspots) and red clover (black stem), see Boerema & *al.* (1965b). Further it often occurs on other Leguminosae, and has been isolated from the plants of other families as well. It has been shown to have a specific inhibitory action on *Pythium ultimum* (Domsch & Gams, 1968b: 170).

Phoma prunicola (Opiz) Wollenw. & Hochapf. *in* Z. ParasitKde **8**: 595. 1936.—Pl. 3 figs. 5, 6; Pl. 6 fig. 6.

Synonyms: *Peyronellaea prunicola* (Opiz) Goid., *Phyllosticta pyrina* Sacc., *Peyronellaea nicotiae* Leduc; for further synonyms, see Boerema & *al.* (1965a, 1968).

Cultural descriptions and illustrations.—Boerema & Dorenbosch *in* Versl. Meded. plziektenk. Dienst **142** (Jaarb. 1964): 144–148., fig. 7 (pycnidia, pycnidiospores, chlamydospores, and dictyochlamydospores), fig. 8 (cultures on OA). 1965; Boerema, Dorenbosch & van Kesteren *in* Persoonia **4**: 59–63, fig. 3 (pycnidia, pycnidiospores, chlamydospores and dictyochlamydospores), pl. 3 (chlamydospores, dictyochlamydospores, and cultures on OA and cherry-agar). 1965; Morgan-Jones *in* C.M.I. Descr. path. Fungi Bact. No. 135 (pycnidia, pycnidiospores, chlamydospores, dictyochlamydospores, mycelium). 1967.

The colonies of *P. prunicola* are generally characterized by the occurrence of different sectors, some with an abundance of pycnidia, others with much aerial mycelium. The colours of the colonies vary from green, white, and grey to black.

A typical and stable character is the production of single chlamydospores, usually produced in chains. They are initially light brown and darken gradually. Dictyochlamydospores are not always produced but they are usually present in fresh isolates. They generally arise as separate terminal spores on mycelial branches, more or less *Stemphylium*-like in shape. Sometimes they also occur in chains together with single chlamydospores.

This soil-borne fungus has been found on all kinds of dead and diseased plant material (Boerema & *al.*, 1965a, 1968) and is known especially in association with leafspots on apple (Boerema & Dorenbosch, 1965), pear and species of *Prunus*. It is considered to be a secondary invader.

Remarks on nomenclature

Pyrenochaeta acicola (Lév.) Sacc. *in* Sylloge Fung. **3**: 220. 1884. — *Vermicularia acicola* Lév. *in* Annls Sci. nat. (Bot.) III, **9**: 259. 1848. — Neotype: dried culture of CBS 260.65 (det. G. L. Hennebert), isolate ('C124') from soil (wheat field) made by W. Gams, Kiel-Kitzeberg, Aug. 1962 (compare Gams & Domsch, 1969a: 17); herbarium 'Centraalbureau voor Schimmelcultures', Baarn (CBS).

Synonym: *Pyrenochaeta spinaciae* Verona & Negru *in* Mycopath. Mycol. appl. **30**: 310. 1966. — Type: Herb. Negru (CL).

The type material of *Pyrenochaeta acicola* described from fallen needles of *Pinus silvestris* in the Vosges does not appear to have been preserved. Its identity with the fungus treated in this paper is in accordance with the interpretation of *P. acicola* as given by Gams & Domsch (1969a: 17), and is based on comparison with an old living specimen named *P. acicola* in the culture collection of the 'Centraalbureau voor Schimmelcultures', CBS 260.38. The latter was isolated by ten Houten (1939: 28) from Dutch seedlings of *Pinus nigra* var. *austriaca* and morphologically agrees very well with the original, albeit vague, description of *Pyrenochaeta* (*Vermicularia*) *acicola*. In order to consolidate this concept a dried culture of a fresh isolate

of the fungus, showing all its typical characteristics, is here formally designated as neotype.

Because of the characteristic setae this *Phoma*-like fungus is maintained in the form-genus *Pyrenochaeta*. In my opinion, however, the status of *Pyrenochaeta* with respect to *Phoma* is still dubious. The spore-forming process in many species of *Pyrenochaeta*, including *P. acicola*, is in complete agreement with that in *Phoma*, even though it is true that several species sometimes show branched conidiophores. In any case the occurrence of setae is not a stable criterion, since various *Phoma*-like fungi occasionally produce setose pycnidia.

Finally it should be noted that an isolate made from original herbarium material of *Pyrenochaeta spinaciae* (seeds of spinach obtained from Prof. A. Negru) proved to be indistinguishable from *P. acicola* as interpreted in this paper.

Phoma chrysanthemicola Hollós *in* Annls hist.-nat. Mus. natn. hung. **5**: 456. 1907. — Neotype: dried culture of CBS 522.66, isolate ('1315') from stem of *Chrysanthemum morifolium* made by H. J. Wilcox, Nat. Agric. Advis. Service Kent, 1963 (compare Hawkins & *al.*, 1963); herbarium 'Centraalbureau voor Schimmelcultures', Baarn (CBS).

Phoma chrysanthemicola was described from decorticated dry stems of cultivated *Chrysanthemum indicum* (= *C. morifolium*) at Kecskemét in Hungary. The original material appears to have been destroyed during the Second World War (information Museum of Natural History, Budapest). In our opinion, however, there is no doubt but that the characteristics as described for the pycnidia and pycnidiospores of *P. chrysanthemicola* justify the use of this name for the soil-borne fungus commonly occurring in association with the root- and stem-rot of florists' chrysanthemums (see Kemp, 1958; Hawkins & *al.*, 1963; and Peerally & Colhoun, 1969). This interpretation also conforms with Srivastava's concept (1953); he examined the fungus in India on several varieties of chrysanthemum seedlings imported from the Netherlands.

It should be remarked that Kemp (l.c.), Hawkins & *al.* (l.c.), and Peerally & Colhoun (l.c.), in their extensive studies on the root- and stemrot disease of chrysanthemums, hesitated about adopting the name *P. chrysanthemicola*, since on the preserved plant material with *P. chrysanthemicola* studied by Srivastava (l.c.), Kemp (l.c.) failed to find the characteristic pseudosclerotial masses (see Table 1 and Pl. 6 figs. 1, 2). Our comparative study of numerous isolates of the fungus, however, revealed that some strains do and others do not produce these pseudosclerotial masses. Moreover in our opinion it is difficult to establish the occurrence of these masses in vitro. Since, furthermore Srivastava's fungus occurred on plant material from the Netherlands we are sure that Srivastava as well as Kemp, Hawkins & *al.*, and Peerally & Colhoun were dealing with the same fungus, agreeing with *P. chrysanthemicola*. To fix the species, a typical dried culture of the fungus (with pseudoclesrotial masses) is selected as neotype.

Phoma eupyrena Sacc. *in* Michelia 1 (5): 525. 1879; *in* Sylloge Fung. 3: 127. 1884. — Holotype: on stems of *Solanum tuberosum*, coll. by P. Brunaud, near Saintes (Charente-Inférieure), no date; Herb. Saccardo '39' (PAD).

In the literature dealing with species of *Phoma* in association with potatoes the name *Phoma eupyrena* is generally used with the emendation 'as interpreted by Wollenweber' or 'sensu Wollenweber', see Dennis (1946), Malcolmson (1958), Boerema & van Kesteren (1962), and Kranz (1963). This means that the authors did not answer the question as to whether the typical, chlamydospores-producing *Phoma* isolated by Wollenweber (1920) from potato tubers (spore dimensions usually 3.4–5.1 × 1.7–2.6 μ) is really identical with Saccardo's fungus (spore dimensions given as 4 × 1.5 μ). Malcolmson's (1958) doubts about this were even strengthened by the absence of any chlamydospores in a specimen on *Solanum dulcamara* in Saccardo's herbarium (PAD). However this specimen, labelled "*P. eupyrena* f. *dulcamarae*" and collected in 1889 by C. E. Fairman in the U. S. A., does not represent the type. It is indeed quite different from the chlamydospores-producing *Phoma*, but it agrees in every detail with a fungus isolated by Kranz (1963: 14, 15) from dried material of *Solanum dulcamara* (spores 4.7–6.3 × 1.7–2.6 μ, 1-celled, 1 %–3 % being 2-celled).

The holotype of *P. eupyrena* Sacc. is still in existence, and its characteristics accord very well with Wollenweber's interpretation. It possesses only 1-celled spores, 3.4–5.1 × 1.7–2.6 μ, while chlamydospores also occur in association with the pycnidia! Therefore since Wollenweber's interpretation of *P. eupyrena* is in agreement with Saccardo's type the indication 'sensu Wollenweber' is superfluous.

Phoma fimeti Brun. *in* Bull. Soc. bot. Fr. **36** (= II, **11**): 338. 1889. — Neotype: dried culture of CBS 170.70, isolate from soil (glasshouse) made by M. A. de Waard, Zwijndrecht, Dec. 1966; herbarium 'Centraalbureau voor Schimmelcultures', Baarn (CBS).

This fungus was originally described from dung of sheep at Fouras near Saintes in France, but the original material was not preserved. The description of the characteristics of pycnidia and pycnidiospores fully agrees with that of the soil-borne fungus treated in this paper under the name *P. fimeti*; it is well known that most coprophilous fungi commonly occur in soil. None of the other 'old' *Phoma* species described show so much similarity with the fungus treated in this paper.

To consolidate this concept of *P. fimeti* a dried culture of a typical soil-isolate of the fungus is designated as neotype.

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EXPLANATION OF PLATES 1—6

PLATE 1

Fig. 1. *Phoma chrysanthemicola.* Photograph made with side-light, showing locally a dense greyish mycelial mat, and red discoloration of the medium (OA) below the colony.

Fig. 2. *Phoma exigua.* Demonstration of the characteristic oxidation-reaction after addition of drops of NaOH: at first the appearance of a conspicuous bluish-green spot (α-pigment), which gradually enlarges and then turns red (β-pigment).

Fig. 3. *Phoma fimeti.* Photograph made with transmitted light, showing the medium (OA) below the greenish colony discoloured yellow.

Figs. 4, 5. *Phoma herbarum.* — Fig. 4. Strain of the mycelial-type, showing different sectors and locally very intense red discoloration of the medium (OA). — Fig. 5. Strain of the pycnidial-type, showing that the reddish discoloured medium below the colony turned blue after addition of a drop of NaOH.

PLATE 2

Figs. 1, 2. *Phoma fimeti.* Twenty-days-old plate cultures. — 1. on OA. — 2. on MA.
Figs. 3, 4. *Phoma herbarum.* Ten-days-old plate cultures. — 3. on OA. — 4. on MA.
Figs. 5, 6. *Phoma glomerata.* Ten-days-old plate cultures. — 5. on OA. — 6. on MA.

PLATE 3

Figs. 1, 2. *Pyrenochaeta acicola.* Twenty-days-old plate cultures. — 1. on OA. — 2. on MA.
Figs. 3, 4. *Phoma chrysanthemicola.* Twenty-days-old plate cultures. — 3. on OA. — 4. on MA.
Figs. 5, 6. *Phoma prunicola.* Ten-days-old plate cultures. — 5. on OA. — 6. on MA.

PLATE 4

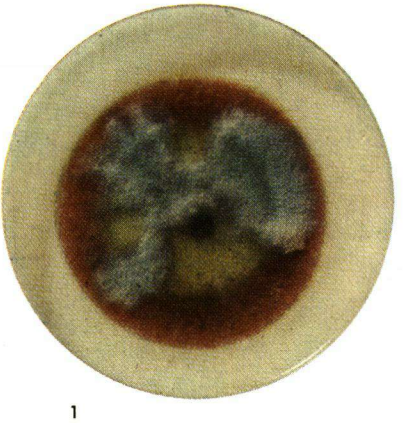
Figs. 1, 2. *Phoma eupyrena.* Ten-days-old plate cultures. — 1. on OA. — 2. on MA.
Figs. 3, 4. *Phoma exigua.* — 3. Ten-days-old plate culture on OA. — 4. Twenty-days-old plate culture on MA.
Figs. 5, 6. *Phoma medicaginis* var. *pinodella.* Ten-days-old cultures. — 5. on OA. — 6. on MA.

PLATE 5

Figs. 1, 2. *Phoma medicaginis* var. *pinodella.* Plate cultures on MA, photographed from below to show the characteristic crystal figures produced in the agar.
Figs. 3, 4. *Pyrenochaeta acicola.* Pycnidia with setae, × 88.
Figs. 5, 6. *Phoma fimeti.* Pycnidia, × 88.

PLATE 6

Figs. 1, 2. *Phoma chrysanthemicola.* Pseudosclerotial masses, consisting of chlamydospores, × 200.
Fig. 3. *Phoma eupyrena.* Chlamydospores, × 140.
Fig. 4. *Phoma medicaginis* var. *pinodella.* Chlamydospores, × 140.
Fig. 5. *Phoma glomerata.* Dictyochlamydospores of two strains, × 140.
Fig. 6. *Phoma prunicola.* Chlamydospores and dictyochlamydospores, × 140.



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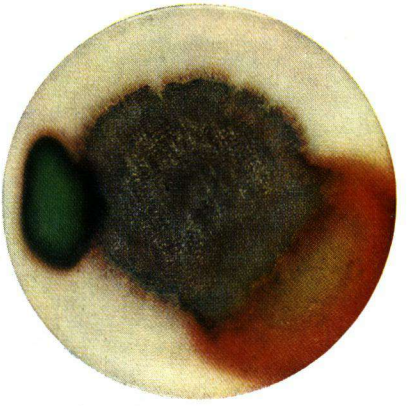

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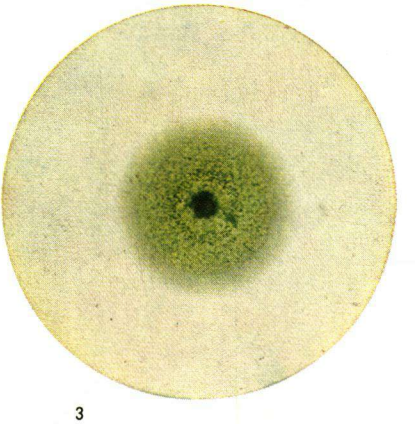

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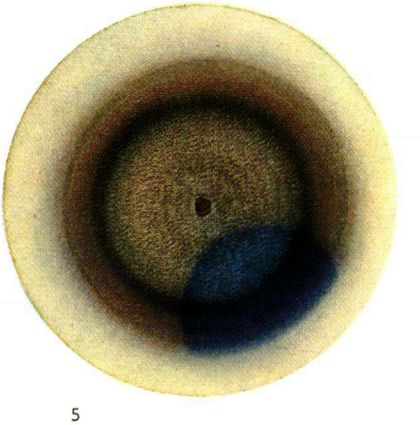

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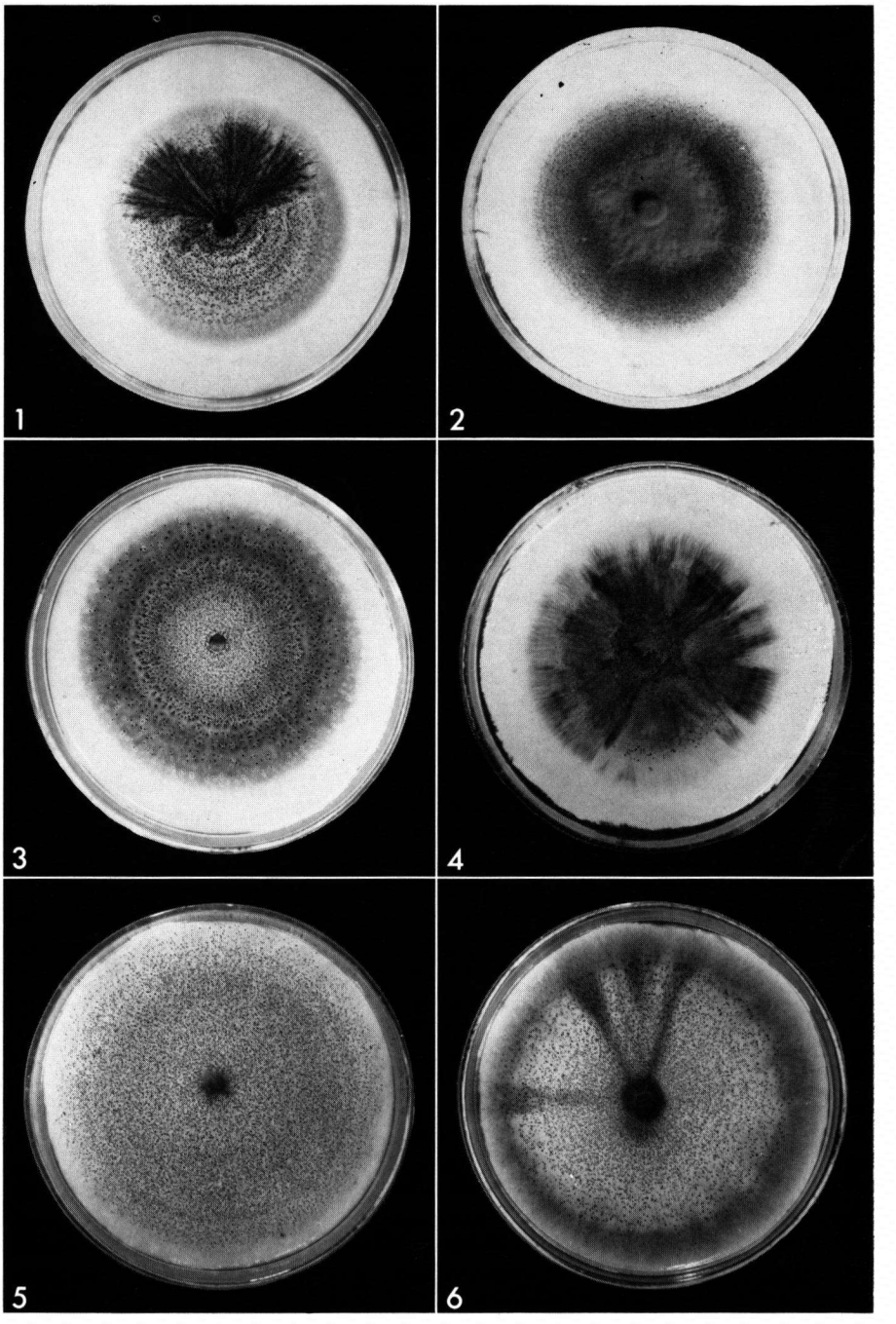
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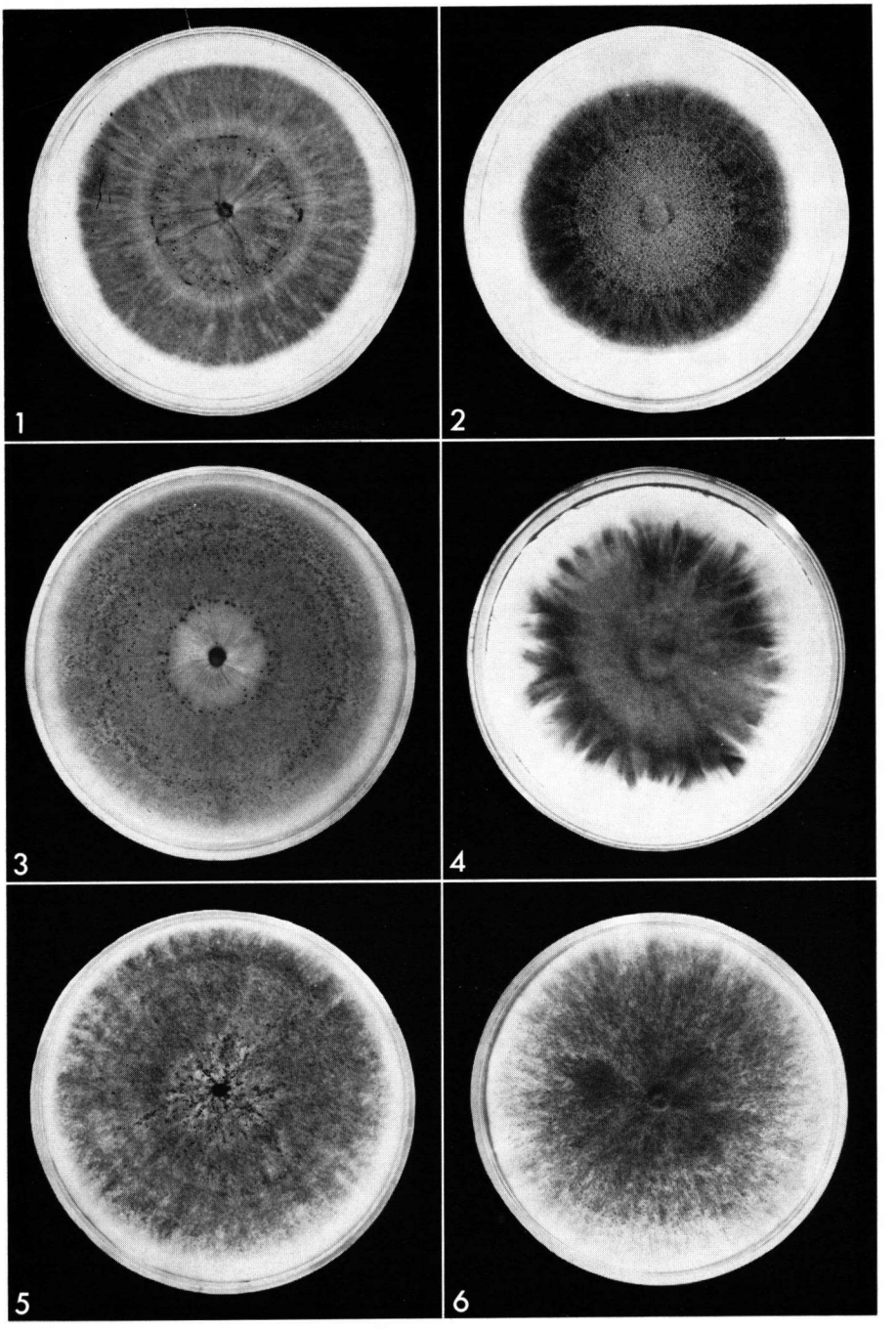
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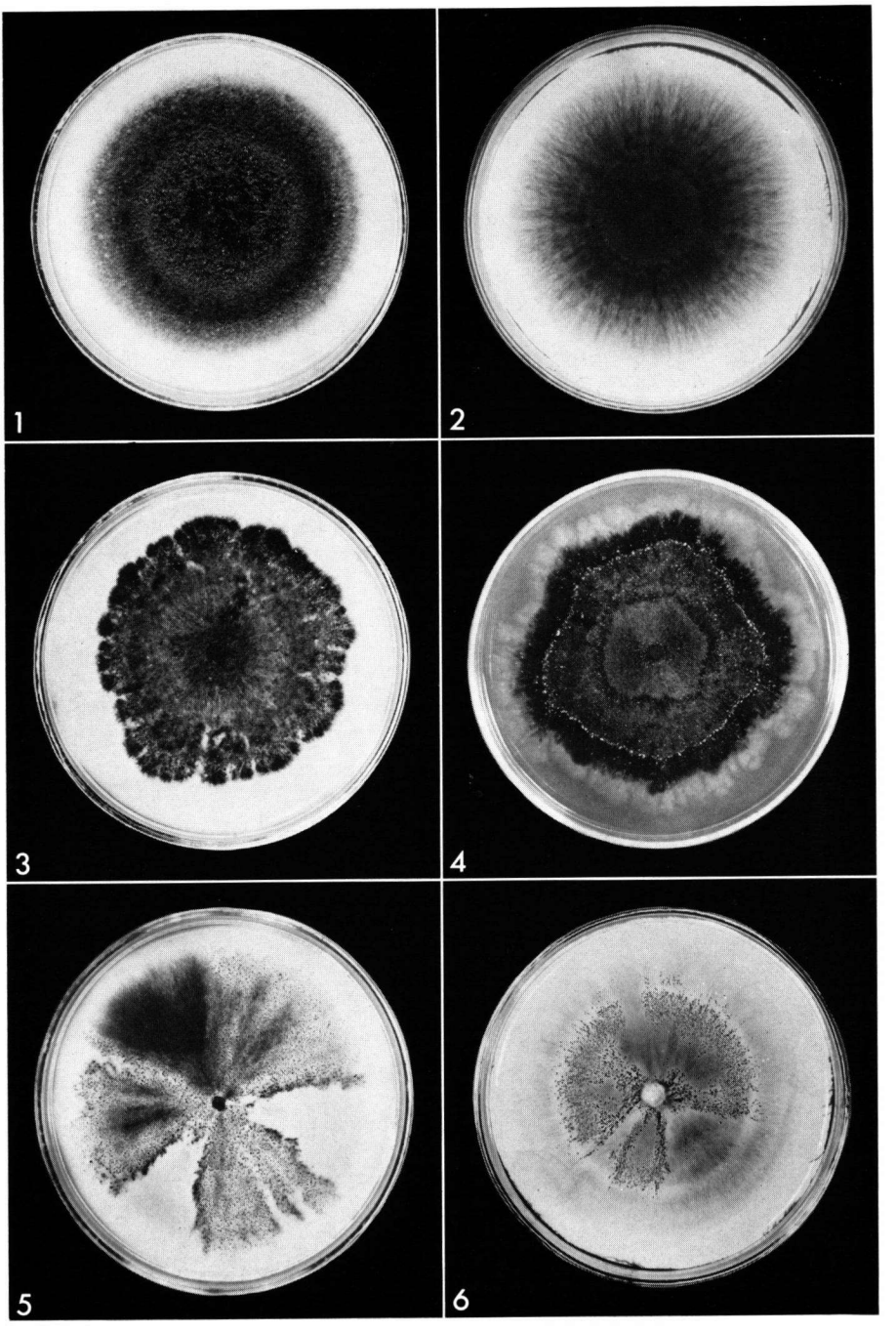
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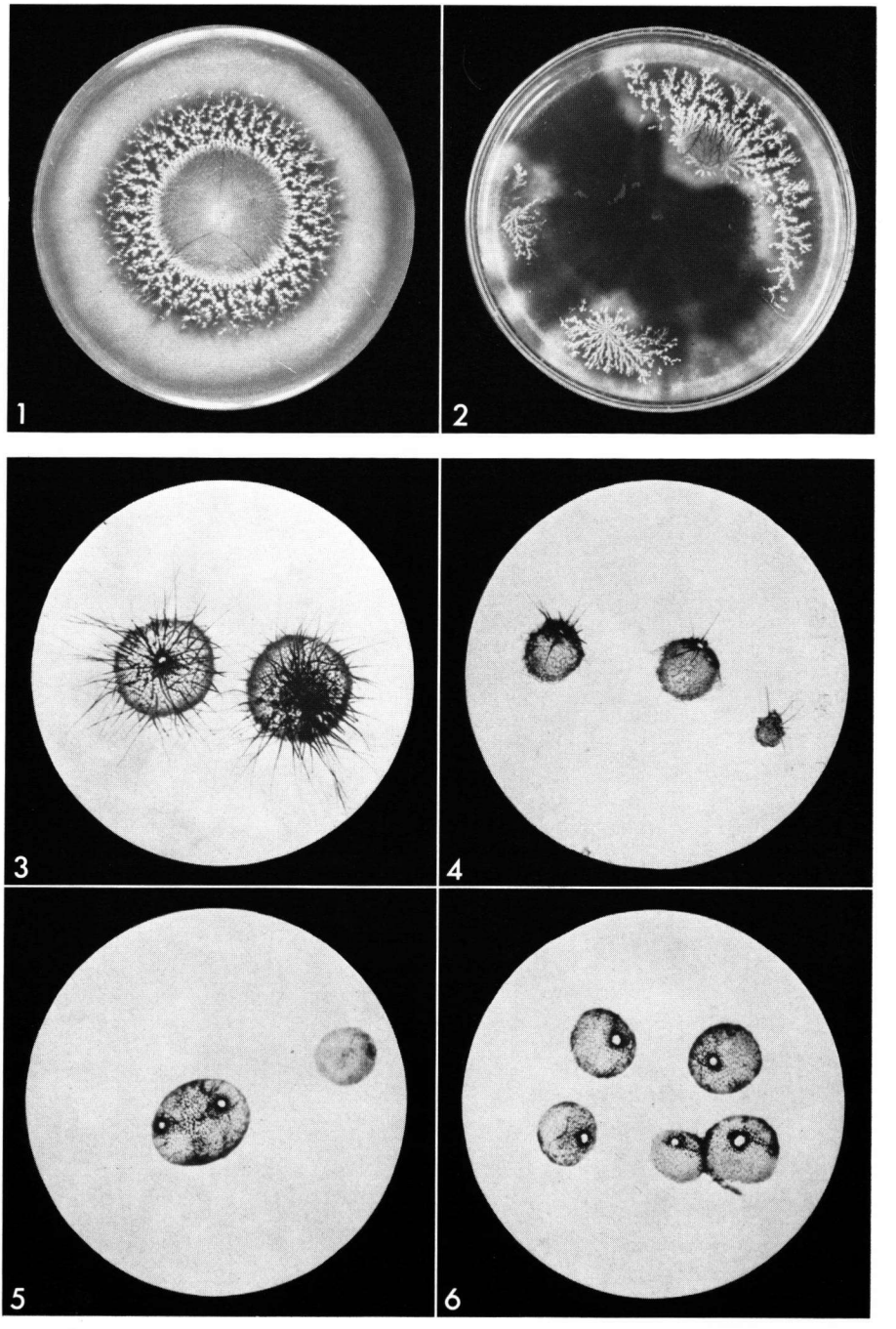
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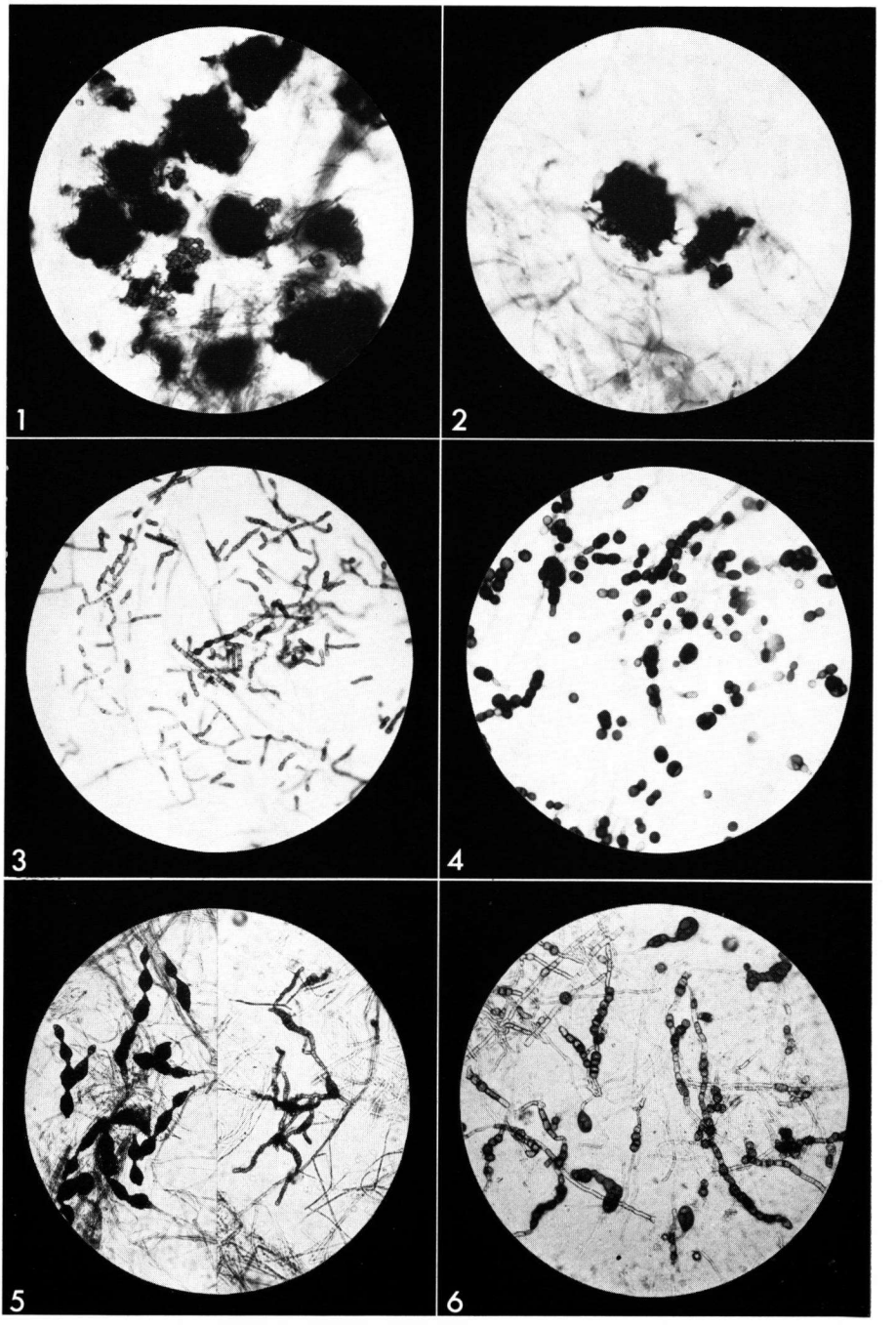
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